



GLOBAL
ALLIANCE
FOR THE
**FUTURE
OF FOOD**

FOOD SYSTEMS OF THE FUTURE:

**A SYNTHESIS OF REPORTS
ON FOOD SYSTEMS
TRANSFORMATION**

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DISCLAIMER

Food Systems of the Future: A Synthesis of Reports on Food Systems Transformation was commissioned from Meridian Institute by the Global Alliance for the Future of Food in order to explore the current thinking around the visions, strategies, and pathways to facilitate food system transformation. The Global Alliance has chosen to make it available to the broader community to contribute to thinking and discussion about sustainable food systems reform. Any views expressed in this report do not represent the views of the Global Alliance or of any of our members.



Prepared by Meridian Institute, at the request of and with support from the Global Alliance for the Future of Food.

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INTRODUCTION

Food systems should provide healthy food and nutrition security; improve social, economic, and cultural well-being; provide secure livelihoods; and enhance biophysical, environmental, economic, and political systems and maintain them for current and future generations. Yet, today's food systems all too often fail to achieve these outcomes. Deep and lasting changes are imperative and will require dialogue across multiple sectors with a confluence of perspectives to develop a collective path forward.

These perspectives are reflected in a number of influential, thought-provoking, and topical reports on food systems and land use published in recent years. In late 2018, at the request of the Global Alliance for the Future of Food, Meridian Institute reviewed 12 major global reports on food systems transformation to share with the members of the Global Alliance at their annual gathering in January 2019. With the release of additional relevant reports over the past year, Meridian updated the synthesis in January 2020.

In total, Meridian reviewed 20 major global reports on food systems transformation published in 2017, 2018, and 2019. This document provides brief summaries of each report, as well as a high-level analysis of cross-cutting themes. Although the reports present unique visions and strategies, all foresee a critical need for food systems transformation in the face of a rapidly changing world and underscore that food systems must be drivers – rather than barriers – of social, environmental, and economic progress.

Meridian used the following criteria to guide the selection of reports:

- **SCOPE.** We focused on reports that present comprehensive visions, strategies, and pathways for achieving diverse, equitable, healthy, interconnected, renewable, and resilient food systems of the future.
- **SCALE.** We prioritized reports that discuss food systems elements, actors, and activities at a global scale. To complement the global perspective, we included two examples of food systems transformation in a regional and local context.
- **INFLUENCE.** We aimed to identify reports from authors and organizations that are well-recognized and respected as thought-leaders and practitioners in the field of global food systems and sustainability.

Approximately a quarter of the reports are not exclusively dedicated to food systems, but rather focus on food systems (and their transformation) as one key driver or strategy to address critical challenges such as climate change and sustainable development.

We summarized each report's:

- **VISION** for a healthy, equitable, renewable, resilient, and culturally diverse future of food shaped by people, communities, and their institutions. We include key contextual factors and drivers of today's broken food systems.
- Proposed **STRATEGIES** to achieve the envisioned outcomes, and the key drivers of change to deliver those outcomes (e.g., technological change; policy change; corporate behavior change; consumer behavior change; reform in agricultural practices) and the scale of those activities.
- Proposed **PATHWAYS FOR IMPLEMENTATION**, focusing on key activities needed to enable change (e.g., engagement of key sectors and stakeholders; governance changes; institutional changes).

The ideas presented in each report do not always fall neatly into these categories, but for consistency and ease of analysis they are presented through this framework. We acknowledge that these summaries, intended to be concise and high-level, likely do not capture the full nuance and specificity of each report.

With an increasing and renewed focus by the global community on creating sustainable, equitable, and resilient food systems, we are likely to see an increase in additional relevant reports. We hope that this synthesis offers a timely and helpful snapshot of current thinking on the major visions, strategies, and pathways for creating sustainable, equitable, and resilient food systems.



OVERARCHING THEMES AND KEY MESSAGES

This section summarizes the visions, strategies, and imperatives – or key values – underlying food systems transformation that surface most prominently and frequently in the reports reviewed. This is not a comprehensive list, nor does it assume consensus across the reports, but it attempts to capture at a high level how major reports envision future food systems and primary pathways to get there.

VISIONS

Each report presents a unique vision for food systems transformation that mobilizes different actors and tools at different scales, but all reports agree on a key point: maintaining the status quo is not an option. Many current agriculture and food systems practices are unsustainable, unhealthy, and inequitable, and bold reform will be urgently needed.

Key elements of the future of food across the reports include food systems that:

- Promote sustainable development by minimizing resource use, causing limited environmental harm, and improving socio-economic outcomes
- Mitigate, adapt to, and build resilience to climate change
- Foster shared economic prosperity, healthy communities, and socio-political inclusion
- Can adapt to growing pressures from population growth, urbanization, income growth, and changes in cultural preferences for food
- Are conscious of the disparate impacts of food system externalities on vulnerable communities
- Are supported by cross-sectoral, multistakeholder governance systems

SOLUTIONS AND STRATEGIES

To achieve these envisioned outcomes, each report outlines a series of proposed solutions. There is no single “silver bullet;” the cross-sectoral nature of food systems of the future means strategies must concurrently be implemented to target various scales, geographies, and pathways of action – such as government policy, corporate action, producer behavior change, and consumer behavior change. The

most prevalent strategies for food systems transformation recommended in the reports are summarized below.

REFORM AGRICULTURAL PRACTICES. Food systems encompass more than agriculture, but this stage of the value chain receives the most focus across the reports given its outsized environmental impact. Most reports agree that industrial agriculture – due to its adverse impacts on health, environment, and workers' safety – is at odds with their visions for food systems transformation. As part of a transition away from industrial, large-scale agriculture, the reports focus on expanding the role of smallholder farmers in food production. The reports also advocate for changing agricultural practices: agroecology is the model most frequently advocated for, with certain reports highlighting climate-smart, organic, and regenerative approaches. Although terminology and specifics of implementation differ, these models encompass similar actions: improve soil health practices; sustainably intensify crops; reduce land, water, and other inputs in livestock production; reduce/more efficiently use fertilizers; improve water management systems; and improve rice cultivation – a specific crop called out by a smaller number of reports due to its high CH₄ emissions – including through better fertilizer and water management.

LOCALIZE FOOD SYSTEMS. As noted above, most reports support a greater role for smallholder farmers in the global food system – a food system that should, according to the various authors, increasingly be regional or local. Geographically-concentrated food systems reduce the environmental footprint of food storage and transport. They also capture economic value within the production area, increasing benefits to farmers and other producers. Smaller-scale markets also facilitate smallholder entry. Many reports also advocate for localized solutions and strategies to food systems transformation, wherein context-specific approaches should be developed at sub-national and national levels to incorporate local knowledge and respond to local cultural preferences. That said, many of the same reports also promote alignment with global agendas such as the Sustainable Development Goals, Paris Agreement, and to a lesser degree the Aichi and other biodiversity targets. They emphasize that the scale of transformation needed is significant, and thus will require action by global actors, including multilateral institutions and corporations.

IMPROVE LAND MANAGEMENT AND STRENGTHEN LAND RIGHTS. Improved land management can improve the quality and quantity of food production and reduce environmental consequences of agriculture. Common recommendations include: limiting conversion of land for agricultural purposes; increasing yield productivity (tied to many of the agricultural practices mentioned above); building the natural resilience of agricultural landscapes to climate change; and promoting biodiverse landscapes. The reports also strongly call for protecting and expanding the land rights of Indigenous Peoples and smallholder farmers, including women.

EXPAND SUSTAINABLE FISHING. The seafood sector was not mentioned in all of the reports, but a number discussed the need and opportunity to expand sustainable fishing and aquaculture – a source of food and livelihood that, if well-managed, can cause fewer environmental harms than agricultural crops and livestock and can lessen the burden of food systems on land.

CHANGE DIETARY PATTERNS. Achieving food systems that are healthier for people and the planet will be difficult, if not impossible, without changes to diets. Some reports advocate for plant-based diets whereas others primarily call for a reduction in beef consumption; a number recommend reducing processed foods. Nearly all of the reports emphasize that dietary patterns must be locally- and culturally-adapted; in particular, populations with high rates of malnutrition should adopt different dietary recommendations. To encourage dietary changes at-scale, many reports point to public health policies and guidelines, public procurement policies, information campaigns and public advocacy, and expanded access to affordable healthy foods. Research and development into meat alternatives is mentioned by a few authors. However, most note that diets are set by individual behavior; beyond advocating for more information for consumers, few reports detail how to drive or incentivize such significant behavior change.

REDUCE LOSS AND WASTE. Harvest, handling, and processing technologies and practices are commonly-cited approaches to reducing losses in food supply chains. To reduce demand-side waste, many reports call for more efficient packaging and encourage changes in consumer purchasing, consumption, and disposal behavior.

SUPPORT RESEARCH AND KNOWLEDGE EXCHANGE. Research is a foundation for food systems transformation – particularly research that directly involves and serves farmers and helps policy-makers make evidence-based decisions. Many reports highlight the role that public institutions should play to facilitate access to knowledge and promote

research that explores solutions for improving the health and sustainability of food systems. The reports place significant attention on research methods. Rather than research grounded in and limited to Western, academic settings, research should seek to elevate traditional and Indigenous knowledge and engage local agricultural communities as active participants in knowledge production and exchange.

ADOPT TRUE COST ACCOUNTING METHODS. Explicit or implicit in most reports is the need to recognize and account for the negative (and positive) externalities of food systems in economic, research, and political systems. True cost accounting can inform decisions that more comprehensively address food system challenges and opportunities, whether in government policy-making or in private sector operations.

REDIRECT FINANCING AND INVESTMENTS. Public-private financing is frequently mentioned as an approach to drive desired food systems transformations. Governments are called upon to invest in research, infrastructure, and social policies, and many reports strongly recommend governments reform their subsidy structures to incentivize and reward environmentally-friendly practices. A smaller number of reports mention the role of philanthropy as well as financial flows from major private investors and banks, which if redirected away from harmful actors and practices towards desired actions could accelerate and amplify food systems transformation.

STRENGTHEN RURAL ECONOMIC DEVELOPMENT. Food systems transformation should seek to bolster rural economies, many of the reports note. Building the climate resilience of the agriculture sector will be critical. In addition, agriculture and food sectors should seek to attract youth by providing diversified, safe, and stable employment, which can mitigate rural out-migration and avoid losing the next generation of farmers. Infrastructural investments and social protections are also strategies mentioned to improve rural development and smallholder livelihoods.

ADAPT TO URBANIZATION. Although nearly all reports mention urban growth as a pressure point, far fewer detail solutions for how food systems can adapt to urbanization or play a role in improving urban livelihoods. A few reports advocate for expanding urban agriculture and improving urban and regional planning to distribute socio-economic pressures and opportunities across a linked rural-urban interface.

IMPERATIVES

Whether implicitly or explicitly, all the reports are guided by core values that guide the “why” and “how” of food systems transformation. These values are imperative to ensuring strategies are implemented in ways that address and do not replicate the deep structural challenges underlying today’s broken food systems. With some variation, a few of these “imperatives” recur across many of the reports.

EQUITY. Equity is at the forefront of food systems transformation: nearly every report stresses that future food systems must benefit and meet the needs of the world’s most vulnerable people. Reforms should focus on eliminating food system practices and externalities that disproportionately harm those communities. In particular, policies should protect and uplift the rights and livelihoods of women, smallholders, and Indigenous Peoples; reforms that strengthen their rights to land and other natural resources are particularly emphasized. Many reports note the deep power disparities that exist in today’s food systems: certain people are excluded from policy-making; are exploited by food systems and do not share in their economic prosperity; and are not valued as leaders in knowledge creation and exchange. Political influence, land, and profits are increasingly concentrated amongst a few major global players. These power dynamics must be overcome in every pathway for food systems transformation in order to achieve equitable outcomes.

SYSTEMS THINKING. The “nexus” of multiple issues and actors takes center stage in these reports. Food systems should be broadly defined and comprehensively addressed: they encompass activities, for example, from the pre-production phase to post-consumption waste management in addition to the externalities caused by those activities. Those externalities affect communities that both directly and indirectly participate in food systems. Researchers, policy-

makers, civil society organizations, media and marketing groups, and many other non-producer actors are also part of food systems, as they influence knowledge, policy, and culture surrounding food systems. Most reports use a systems approach that recognizes this expansive definition of food systems to develop their visions and strategies, calling for: interdisciplinary research and cross-sectoral policies that span traditional issue silos (e.g., health, environment, infrastructure, agriculture, etc.); require the participation of diverse stakeholders; and, acknowledge the many geographic and cultural contexts that shape the world's food systems. Notably, most institutions (particularly in government or academia) are currently largely unsuited to embark upon such transformational change due to their siloed organizational structures and processes.

MULTISTAKEHOLDER MOBILIZATION AND ENGAGEMENT. Implementation of food systems transformation relies on the mobilization of a diversity of stakeholders representing different communities and sectors. Inclusion of and collaboration between multiple stakeholders improve the likelihood that solutions are responsive to real needs and tackle those multifaceted needs in tandem; will not disparately affect or leave out particular communities; and will be culturally-adapted and publicly accepted, enhancing their longevity.

DEMOCRATIZATION OF FOOD SYSTEMS. Food systems have become more industrialized, globalized, and digitalized, and as a result, the public has grown increasingly distant from their food value chains. Yet, many visions of future food systems require the public's active participation: consumer behavior drives population health, corporate behavior, and food markets. In addition to public engagement, several reports call for greater public control over resources (including land, technology, innovation, knowledge, and information) and reduced corporate concentration of power and value. As part of democratizing food systems, most reports emphasize the need to uphold cultural values in food systems – for example, through forms of agriculture that align with local traditional practices, strong local markets, and dietary options that account for food traditions and preferences.

TECHNOLOGY AND INNOVATION. Technology may have driven the industrialization of food systems and accelerated some of their adverse effects, but many reports maintain that technology and innovation have central roles to play in food systems transformation. Certain agricultural tools, such as those that enhance precision farming techniques, support the transition to agroecological and other practices. Advances in transportation, processing, and harvest technologies can reduce loss and waste. Innovations in data collection and diffusion can improve consumer access to information and improve supply chain management. Most reports caution that technology can exacerbate power imbalances if it is not made accessible to resource-limited users, and if research and development only favors the needs of corporate actors.

Food systems for sustainable development: Proposals for a profound four-part transformation. Caron, P., Ferrero y de Loma-Orsio, G., Nabarro, D., Hainzelin, E., Guillou, M., Andersen, I., Arnold, T., Astralaga, M., Beukeboom, M., Bickersteth, S., Bwalya, M., Caballero, P., Campbell, B.M., Divine, N., Fan, S., Frick, M., Friis, A., Gallagher, M., Halkin, J.P., Hanson, C., Lasbennes, F., Ribera, T., Rockstrom, J., Schuepbach, M., Steer, A., Tutwiler, A., Verburg, G. 2018. *Agronomy for Sustainable Development*.

VISIONS FOR GLOBAL FOOD SYSTEMS

According to the authors of this paper, sustainable development cannot occur without the eradication of food insecurity and malnutrition; healthy ecosystems; community resilience to climate change; and just, equitable governance. This report envisions future food systems that can – and must – be key levers for achieving these outcomes, as they:

- Provide nutritious and healthy food for all.
- Encourage sustainable agricultural production and food value chains.
- Mitigate and build resilience to climate change.
- Boost socio-economic development in rural areas.

Rather than focus exclusively on food production and agriculture, this report considers broader social, economic, and environmental issues in food systems to achieve multiple goals in unison, in particular those outlined in the Sustainable Development Goals (SDGs) and Paris Agreement. In addition, the proposed transformations look beyond only negative externalities to consider opportunities for food systems to drive positive outcomes.

PROPOSED STRATEGIES

Promote sustainable farming and land use practices.

Agricultural systems, as major contributors to global greenhouse gas emissions, must coexist with healthy ecosystems and mitigate climate change. Two examples of sustainable practices mentioned by the authors are agroecology and organic farming. They also note that agricultural systems will need to reduce their resource use and land footprint to be more “climate-smart.” Climate-smart agriculture, in addition to lowering the climate impacts of agriculture, strengthens the socio-ecological resilience of rural communities and landscapes.

Change food consumption patterns. Demand for food will grow globally as the world’s population grows, with demand particularly increasing in cities due to rapid urbanization. Dietary changes and reductions in food wastage will be necessary to adequately meet these future needs.

Foster socio-economic development. Agriculture is foundational to millions of livelihoods worldwide, and has the potential to achieve multiple SDGs if it economically empowers smallholder farmers, particularly women. Agriculture should provide steady and safe employment and encourage gender inclusion, which fosters shared economic growth. Notably, social stability and economic prosperity strengthens a community’s resilience to climate change.

Invest in rural territories. The authors propose a “rural renaissance,” which describes a symbiotic relationship between rural and urban areas and is an alternative to the pattern of urbanization that has deprived rural areas. Key to this shift is integrated territorial planning; strengthened local institutions to support people’s well-being; and political and cultural investment in a strong rural agriculture sector that can mitigate rural out-migration.

PATHWAYS FOR IMPLEMENTATION

The authors’ use of the term “transformation” is intentional: their vision calls for radical, collective, and long-term change.

Their proposed pathway for implementation requires the mobilization of multiple stakeholders, notably those populations who are most marginalized and disenfranchised. Power imbalances and conflicts of interest are inherent in today’s global food systems; the report emphasizes the need to resolve these prior to launching the multistakeholder processes crucial to the equitable, effective implementation of the proposed strategies.

Implementation must also occur at multiple levels through concurrent strategies in multiple sectors. Local and national action should be planned, implemented, and monitored by local and national leaders, but be aligned with and guided by a global framework for sustainable development (such as the SDGs). Importantly, the authors emphasize the need for local and national interventions to be context-adapted. Researchers and political leaders play a significant role in developing diverse place-based solutions rather than relying on one-size-fits-all approaches.

REPORT 2

Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. EAT-Lancet Commission.² 2019. *The Lancet*.

VISIONS FOR GLOBAL FOOD SYSTEMS

Food systems transformation is the single strongest lever to radically improve both environmental sustainability and human health, the EAT-Lancet Commission states in this report. Although the two issues have traditionally been addressed separately, the Commission stresses that they must be addressed in unison, particularly given the close links between diets, health, and environment. Accordingly, the vision outlined in this report describes a future global food system that is both healthy and sustainable:

- The world adopts a “**planetary health diet**” that meets scientific targets for human health and environmental sustainability, thus remaining within a “safe operating space.”
- Both the Paris Agreement targets and the Sustainable Development Goals (SDGs) are achieved through a common environmental and health agenda, at international and national scales.

The authors project that the estimated global population in 2050 can be nutritiously and sufficiently fed within that “safe operating space” if the interventions described below are rigorously implemented in coordination. However, they caution that even small deviations from the proposed consumption and production practices and health and environmental targets will result in a failure to achieve the report’s vision for a healthy and sustainable global food system.

PROPOSED STRATEGIES

Radically change food consumption patterns. The Commission developed and proposes an optimal diet that meets caloric and other dietary needs but also results in fewer environmental impacts compared to current diets. A key component relies upon reducing animal-source food (notably meat and dairy) and shifting to a diet largely composed of plant-based foods. Importantly, however, the authors emphasize that diets must be adapted by individuals and populations to reflect unique cultural, geographic, and demographic characteristics. For example, the authors caution that the proposed diet is not fit for settings with high undernutrition or malnutrition.

Transform food production practices. The report identifies six environmental targets upon which to focus food systems reform: climate change, land system change, freshwater use, nitrogen cycling, phosphorus cycling, and biodiversity loss. Sustainable agricultural intensification, strict land use and crop management, and improved fertilizer and water use efficiency are some of the strategies proposed to transition global food systems to be more sustainable and to mitigate their climate impacts. Overall, the reports advocate for a reorientation of agricultural priorities from quantity alone to improving the quality of outputs.

Significantly reduce food loss and food waste. This key strategy is tied to both the production and consumption-side strategies highlighted in the report. The authors call for halving food loss and food waste; this will be a critical component of food systems transformation and the proposed “safe operating space” targets cannot be met without a substantial strategy to achieve this. Proposed approaches include improving post-harvest infrastructure, food transportation, and processing and packaging practices.

PATHWAYS FOR IMPLEMENTATION

The report describes multiple pathways for implementation that must be leveraged to succeed in a global adoption of a planetary health diet. Government, industry, and civil society must be involved. Technological solutions can assist in improving agricultural production practices and implementing strategies to reduce food loss and waste. Social systems and institutions, such as health care and education, play an important role in providing dietary interventions and urging public awareness and behavior change. Scientific research plays a critical function to close the gap between evidence and policy.

Political mobilization and policy action are some of the most important pathways for change identified in the report. International and national commitment to food systems transformation must result in policies that make healthy foods more available, affordable, and accessible; in improved governance of land and oceans; and in other systems-level implementation of food systems reforms key to achieving a healthier, more sustainable future.

² The Commission convened 37 scientists from 16 countries to contribute to the report as advisors and co-authors.

TEEB for Agriculture and Food: Scientific and economic foundations. The Economics of Ecosystems and Biodiversity (TEEB).¹ 2018. UN Environment.

VISIONS FOR GLOBAL FOOD SYSTEMS

Efforts to reform food systems narratives and policies are inadequate, the TEEBAgriFood authors argue, as they frequently only focus on the production stage and therefore fail to address the range of social and environmental issues across long value chains. In contrast, this report coins a new approach of looking at “eco-agri-food systems,” which include all stages of growing, processing, distributing, and consuming food. This approach encompasses both tangible and non-tangible components of food and agriculture, from culture to technology to policy to infrastructure. In their vision:

- Food systems provide nutritious and healthy food for all.
- Natural ecosystem services are recognized as fundamental to agriculture and are protected accordingly.
- Food systems positively contribute to human and planetary health.
- Leaders across different sectors and areas of expertise work together to systemically drive change and achieve healthier, more equitable, environmentally-sustainable food systems.
- Multiple outcomes are met in coordination: the agronomist perspective (focused on feeding a growing population) collaborates with the environmentalist perspective (whose goal is saving the planet), the sociologist perspective (goal of sustainable rural livelihoods and social equity), the economist perspective (goal of cheap food through efficient markets), and the health perspective (goal of healthy diets).

PROPOSED STRATEGIES

Change dietary patterns. Diets that are both healthier and reduce greenhouse gas emissions are not only necessary but possible through a reduction in meat consumption and investments in agricultural biodiversity.

Promote human and planetary health. Policies must restrict the use of potentially harmful chemicals and instead promote technology, renewable energy, and materials for safer, more efficient production, processing, storage, and transportation of food. In addition, strategies to improve the nutrition of children during their first 1,000 days should be prioritized as this period critically affects future health outcomes.

Prioritize social equity, justice, and food security. These should be core values of our food systems and foundational to

sustainability initiatives, food safety, marketing, trade, diets, animal welfare, and effective, accountable, and inclusive institutions at all levels. These institutions should invest in pro-poor policies that, in part, enhance social protections for those whose livelihoods rely on food value chains.

Reduce food waste. Cutting food waste is an environmental and social necessity. A priority should be to increase investments in affordable post-harvest loss technologies.

Mitigate climate change. To keep global warming within 2°C, multiple strategies are necessary, including scaling up agroecology, reducing food loss, reducing feed production, changing global dietary patterns, disincentivizing the use of fossil fuels, and accelerating adoption of renewable energy.

PATHWAYS FOR IMPLEMENTATION

Institutions and initiatives must bridge current silos of research and policy to implement the above strategies and achieve the Sustainable Development Goals (SDGs) in a cross-sectoral manner. New institutions and financing models can also more effectively manage the eco-agri-food system by coordinating and leveraging the complementary roles of the state and the market.

These new governance models must be built upon an understanding of how food systems impact environment and society. To this end, TEEBAgriFood developed an **economic framework to calculate the “true cost of food”** intended to help policy makers, agri-businesses, farmers, and civil society organizations manage and transform eco-agri-food systems. TEEBAgriFood envisions that these actors can use the framework to better provide nutritious food to all without unintended environmental consequences.

In the words of the authors, the framework is comprehensive; in contrast to common simplistic single metrics – that look solely at production yields, for instance – this framework evaluates visible and invisible impacts of the food system along the entire value chain. It is universal; it can be used in any geographical, ecological, or social context and at any scale. Finally, it is inclusive; it supports multiple approaches to assessment, while acknowledging that it uses economic and monetary metrics to evaluate natural, human, social, and produced capital and food system impacts that may be valued in other ways.

¹ The Economics of Ecosystems and Biodiversity (TEEB) is comprised of more than 150 experts from 33 countries who contributed to the development of this report.

The state of food and agriculture: Leveraging food systems for inclusive rural transformation.
Food and Agriculture Organization (FAO). 2017.

VISIONS FOR GLOBAL FOOD SYSTEMS

Rural development is essential to eradicating hunger and poverty, the 2017 edition of *The State of Food and Agriculture* concludes. While industrialization was once the driver of socio-economic transformations, today “late transforming” low-income countries that lag in industrialization (particularly in sub-Saharan Africa and South Asia) must turn to other strategies. They will depend on inclusive and sustainable transformations in agriculture that:

- Create on- and off-farm jobs through an attractive and diverse agro-industrial sector.
- Slow urbanization through employment and poverty reduction in rural territories.
- Reduce natural resource use while achieving food and nutrition security.
- Recognize and protect the cultural and social dynamics inherent in food systems.
- Promote agroterritorial planning to forge a connected rural-urban interface.

Current trends in these “late transforming” contexts underline the urgency of implementing the FAO’s vision. Job opportunities in rural areas are insufficient to keep pace with rapid population growth, particularly amongst youth; as a result, households are increasingly exiting agriculture and migrating to cities. Unfortunately, without urban industrialization or other drivers of economic development, cities cannot support this population growth either. The smallholder farmers that remain in rural areas face land fragmentation and natural resource constraints in addition to the increasing effects of climate change. They struggle economically from the competition of cheap imported goods but face difficulties entering global agribusiness due to stricter regulations, requirements of scale, or barriers in infrastructure or communications. These problems intersect with the growing challenge of increased demand for food arising from demographic and consumption changes.

PROPOSED STRATEGIES

Expand value chains. Stronger agro-industry can foster job creation (on- and off-farm) and increase food production. It would create varied, complementary opportunities for farmers to sell, process, and package their goods; offer employment at

midstream and downstream segments of the food system, thus diversifying the economy; and amplify links between agricultural rural zones and agro-industrial towns and cities.

Develop integrated planning strategies. The above strategy is supported through policy interventions, infrastructure, and investments in planning approaches that connect rural and urban areas. Smaller cities and towns have the potential to be points of intermediation along the agriculture/agro-industry value chain, resulting in more balanced economic growth and population distribution. The authors suggest a few agroterritorial planning models – such as agro-corridors, agro-clusters, agro-industrial parks, agro-based special economic zones, and agribusiness incubators – to achieve these outcomes.

PATHWAYS FOR IMPLEMENTATION

The report urges that government support for rural development, and its empowerment of smallholder farmers in particular, is essential to the implementation of food systems transformation. Common urban biases in public policies will need to be overcome in order to achieve this more inclusive, sustainable approach to national and regional development.

The development constraints of rural areas are context-specific – therefore, so must be the policy interventions. That said, the report identifies several structural reforms that are foundational to the eventual implementation of the proposed strategies. The report suggests governments take the lead to:

- Improve rural infrastructure, both physical infrastructure (e.g. roads) and communications.
- Enact legal, regulatory, and policy frameworks that improve market effectiveness and facilitate the entry of small farmers.
- Provide incentives for investments in agroterritorial strategies.
- Support smallholder farmers by promoting farmer organizations; clarifying and strengthening land and resource tenure rights; improving farmer access to knowledge and technology; and improving social protection policies.
- Invest in public research tailored to the needs of smallholder farmers.

Growing better: Ten critical transitions to transform food and land use. Food and Land Use Coalition (FOLU). 2019.

VISIONS FOR GLOBAL FOOD SYSTEMS

The Food and Land Use Coalition (FOLU) Global Report identifies 10 critical transitions for food systems transformation by 2050 that, if implemented with the scale of investment and reform necessary, could achieve:

- **Better environmental outcomes**, including no biodiversity loss, restored ocean fish stocks, and reduced air pollution.
- **Better health outcomes**, including an end to undernutrition, a sufficient supply of nutritious food, and reduced disease burdens associated with malnutrition.
- **Inclusive development**, including higher income growth, increased yields for low-productivity smallholders, rural employment, and a secure future for Indigenous Peoples.
- **Food security**, including stabilized or reduced real food prices.

The report emphasizes that achieving these transformations will require investment and reform at a significant scale – amounting to billions to trillions of U.S. dollars. However, these transformations could also deliver opportunities to businesses that are financially equal to, if not greater than, than the value of investment.

PROPOSED STRATEGIES

The 10 critical transitions proposed in the report are grouped into four interdependent and mutually reinforcing layers. Although all transitions will be necessary, each country should prioritize their implementation based on local context and needs.

Layer 1: Nutritious food. The report highlights the need for diets to shift towards predominantly plant-based foods and away from highly-processed foods. Consumers should be empowered to make better-informed decisions about their diets. Notably, dietary changes should be locally-adapted.

Layer 2: Nature-based solutions. Recommended transitions include adopting productive and regenerative agricultural systems that combine traditional techniques with advanced precision farming technologies; protecting and restoring nature by ending conversion of forests and investing in forest restoration; and safeguarding oceans, including through sustainable fishing and aquaculture, natural habitat restoration,

and pollution prevention.

Layer 3: Wider choice and supply. This layer of transformation requires diversifying sources of protein in human diets, primarily towards aquatic, plant-based, insect-based, and laboratory-cultured sources. Food – particularly in cities – should also be sourced from scale-efficient and sustainable local food economies. In addition, the report calls for reducing food loss and waste.

Layer 4: Opportunity for all. Three transitions fall under this category: 1) digitizing food and land use systems, which can improve producer and consumer decision-making and strengthen connections across the value chain; 2) fostering resilient and strong rural livelihoods, which underpin all ten transitions; and 3) encouraging gender equity and a demographic transition to a replacement rate of fertility in all countries.

PATHWAYS FOR IMPLEMENTATION

Implementing and achieving the above transitions will require collaborative, cross-cutting action by:

- **Government**, which can convene stakeholders, pass health guidelines, enact fiscal instruments to drive reform, promote open-source research & development, invest in public infrastructure, and more.
- **Business leaders**, who can voice support for government reform agendas, reshape their supply chains, and adopt corporate targets in line with the Sustainable Development Goals (SDGs) and Paris Agreement.
- **Private investors**, whose instruments and investments can be leveraged to transform food and land use systems.
- **Civil society**, including the philanthropic community, which can shape social movements and drive awareness.
- **Multilateral institutions** such as the United Nations, multilateral development banks, and International Monetary Fund, which can support and inspire governments' reform agendas through strategic advice and investments.

Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. High Level Panel of Experts (HLPE) on Food Security and Nutrition of the Committee on World Food Security. 2019.

VISIONS FOR GLOBAL FOOD SYSTEMS

The HLPE report focuses on strategies to achieve Sustainable Development Goal 2: ending hunger and all forms of malnutrition by 2030. The report analyzes strategies to address food security and nutrition through a systems lens, noting that a growing world population, urbanization, and climate change affect all aspects of food systems. The authors outline a vision of food systems that:

- Ensure appropriate food production and reduce loss and waste.
- Safeguard human and environmental health, political stability, and better livelihoods with fewer environmental consequences.

The report focuses much of its analysis on **agroecological approaches**. The report suggests that agroecology can ensure regenerative use of natural resources and ecosystem services. By applying scale-specific, context-specific processes, agroecology can also address the need for socially equitable food systems by allowing people to exercise greater choice over what they eat and how and where it is produced.

PROPOSED STRATEGIES

The report consolidated 13 agroecological principles around which many of its recommendations are based: 1) recycling; 2) reduced use of inputs; 3) soil health; 4) animal health and welfare; 5) biodiversity; 6) synergy between elements of ecosystems including animals, crops, trees, soil, and water; 7) economic diversification; 8) co-creation and horizontal sharing of knowledge; 9) social values and diets; 10) fairness; 11) connectivity between producers and consumers; 12) land and natural resource governance; and 13) democratic participation in decision-making. These principles are intended to underpin locally-adapted strategies based upon local knowledge and the participation of local actors.

Overarching recommendations include:

- Redirect **subsidies and incentives** to support sustainable and mixed livestock, fish, cropping, and agroforestry systems.

- Support participatory and inclusive **territorial management planning**, including by supporting customary land rights for small-scale producers.
- Improve farmers' access to **genetic resources and intellectual property** through international agreements and national regulations.
- Strengthen regulations on the use of **chemicals** harmful to human health and the environment
- Promote **healthy and diversified diets** through education and awareness, appropriate food labelling and certification, support for low-income consumers, and the use of public procurement policies.
- Support food value chain **innovation platforms, incubators, and aggregation mechanisms** that invest in and reward sustainable food producers.

PATHWAYS FOR IMPLEMENTATION

- Strengthen support for research and reconfigure knowledge generation and sharing to foster co-learning. This includes investments in public and private research and development transdisciplinary research, stronger agriculture extension and public health training programs, and improved technology transfer mechanisms. These actions would help bridge knowledge gaps resulting from past underinvestment in research on agroecological approaches.
- Strengthen agency and stakeholder engagement, empower vulnerable and marginalized groups, and address power inequalities in food systems. This includes legal resource protections, recognition of gender equity as a key driver of agroecological transitions, and stronger producer associations and coops.
- Establish and use comprehensive performance measurement and monitoring frameworks for food systems. This includes recognizing true cost accounting measures and redirecting investments (particularly agriculture subsidies) to support farms based on sustainability performance metrics.

The future is now: Science for achieving sustainable development (Global Sustainable Development Report 2019). Independent Group of Scientists Appointed by the United Nations Secretary-General.³ 2019. United Nations.

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The United Nations' 2019 Global Development Report focuses on six entry points with the most promise for achieving the 2030 Sustainable Development Goals (SDGs): human well-being and capabilities; sustainable and just economies; energy decarbonization with universal access; urban and peri-urban development; global environmental commons; and food systems and nutritious patterns (the focus of this summary). If the transformations outlined in the report are achieved, the food systems and nutritious patterns of the future will:

- Deliver nutritious food to a global population of 9-10 billion within decades.
- Greatly reduce the environmental and climate impacts of food systems.
- End hunger and malnutrition.
- Address water scarcities.
- Protect life in water and on land.

PROPOSED STRATEGIES

Promote food that meets nutritional and environmental standards, taking into consideration local contexts and cultures. Social protection floors, regulation and guidelines, and economic incentives are strategies proposed to promote affordable, sustainable, nutritious diets.

Transition production and land use practices towards agroforestry and agroecology; discourage excess use of fertilizers and maximize water use in production; and diversify species and genetic resources from the field to landscape levels.

Reduce food loss and waste through regulation of packing, transportation, and industrial waste practices.

PATHWAYS FOR IMPLEMENTATION

The report identifies a number of impediments that must be overcome to realize food systems transformation and achieve of the SDGs. These include **institutional deficits** (smallholders have insufficient access to institutional, legal, and financial support); **concentration of ownership**, which reduces the resilience of the global food system and impedes small-scale farmers; widespread **damaging agricultural practices** that have degraded land and contributed to GHG emissions; and threats **to food security**, including climate change and plant and animal diseases. To address these challenges and implement the proposed strategies, the report identifies four levers:

- **Governance:** Tools include social protection floors and other social programs, legislation to discourage unsustainable production practices, and mandatory certification and labelling in supply chains.
- **Economy and finance:** Tools include insurance to help smallholders, trade agreements to facilitate universal access of nutritious and sustainable food, and food pricing to favor nutritious and environmentally-friendly food.
- **Individual and collective action:** Tools include awareness-building around food waste, promotion of meat alternatives by the private sector in developed countries, and integrated food and nutrition support and services.
- **Science and technology:** Tools include information systems that facilitate farmer access to market and provide information on climate and production, as well as innovations in production practices to lower environmental impacts and improve nutritional quality.

³ The Global Sustainable Development Report was prepared by an independent group of scientists appointed by the UN Secretary-General, comprising 15 experts from various regions and representing a variety of scientific disciplines and institutions.

Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Intergovernmental Panel on Climate Change (IPCC). 2019.

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The IPCC report discusses five land challenges: climate change mitigation, climate change adaptation, desertification, land degradation, and food security. Agriculture and food systems appear as drivers and solutions in each of these categories. The report's recommendations – or “response options” – to drivers including population and income changes, changes in consumption patterns, and extreme weather events are intended to:

- Avoid land use change or avoid creating additional land conversion.
- Contribute to eradicating poverty and eliminating hunger.
- Promote good health and wellbeing.
- Promote clean water and sanitation, climate action, and life on land.

PROPOSED STRATEGIES

Land management. Recommendations include improving cropland management, food productivity, grazing land management, livestock management, agroforestry, soil management, and agricultural diversification; reducing grassland conversion to cropland; and integrating water management practices.

Value chain management through *demand* management. Recommendations include reducing post-harvest losses and consumer and retailer food waste. The report also advocates for a “contract and converge” model of dietary change that involves reducing overconsumption of livestock in over-consuming populations but increasing consumption of certain food groups within populations facing undernutrition or malnutrition.

Value chain management through *supply* management. Recommendations include increasing sustainable sourcing practices, enhancing efficient and sustainable food transport, improving policies for food supply stability, strengthening urban food systems, improving food processing and retailing, and improving energy use in food systems.

Risk management. Recommendations include managing urban

sprawl (which threatens food production in areas surrounding cities), diversifying livelihoods, promoting and facilitating the use of local seeds, improving disaster risk management, and encouraging risk-sharing instruments such as credit services, insurance, and intra-household risk pooling.

PATHWAYS FOR IMPLEMENTATION

To successfully implement needed transformations in the land sector, a number of governance obstacles will need to be overcome. The report points to Institutional fragmentation and lack of engagement between stakeholders at different scales as factors that prevent effective and transformative change. The slow speed of most policy cycles delays implementation. On the technological front, widespread and large scale application of particular agricultural solutions is limited without the existence of or access to the right technology. The report outlines a few pathways to implementation that could address these challenges, but they will require:

- Businesses, consumers, land managers, Indigenous Peoples and local communities, scientists, and policymakers working together to define problems, share knowledge, and identify solutions.
- Connecting science knowledge and on-the-ground practice, and incorporating local knowledge in policy implementation.
- Including women as key stakeholders in implementation.
- Deliberately coordinating across multiple scales, actors, and sectors. Cross-sectoral engagement can be facilitated by framing land sector actions as strong pathways to sustainable development, a broader agenda favored by multiple parties.
- Improving community-based implementation and engaging farmers, which will require a higher level of social trust and capital.

Global Warming of 1.5°C. Intergovernmental Panel on Climate Change (IPCC). 2018.

VISIONS FOR GLOBAL FOOD SYSTEMS

Global warming is likely to reach 1.5°C between 2030 and 2052 – a landmark which would cause disastrous consequences for the world, as explored through modeling in this report. 1.5°C is far from an aspirational vision for the future, but its impacts would be significantly less severe compared to a 2°C increase. The authors' visions for the next few decades call for:

- Enacting transformational mitigation and adaptation strategies, including in food systems, to limit global warming to 1.5°C and avoid irreversible consequences from further warming.
- Slowing and eventually halting anthropogenic global warming in order to minimize expected climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth.

Today's food systems are already impacted by global warming, shedding light – with less extremity – on the future beyond 1.5°C. Certain populations disproportionately face significant climate change impacts: these include poor households, Indigenous Peoples, and communities dependent on agricultural or coastal livelihoods. All demographics groups – particularly in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon – should expect reduced food availability. Crop yields will decrease, as will the nutritional quality of CO₂-dependent crops such as rice and wheat. Livestock will be affected through changes in feed quality and quantity, increased disease, and water scarcity.

PROPOSED STRATEGIES

The report proposes multiple actions to limit global warming to 1.5°C with no or limited overshoot. Transformations in food systems and agriculture are a priority, though the authors emphasize that significant action is needed in a wide range of interconnected arenas to achieve the scale of change necessary to reverse current trends.

Reform land use practices. In order to limit global warming to 1.5°C, areas of pasture and non-pasture agricultural land currently used for food and feed crops will need to be converted into bioenergy sources and into forests, and ecosystem restoration will need to be prioritized. To reduce demand for agricultural land, the authors suggest:

- Promoting sustainable intensification agricultural practices.
- Transitioning to less resource- and greenhouse gas-intensive diets and reducing material consumption.
- Removing socio-economic, institutional, technological, financing, and environmental barriers to land conversion. These differ by geography, so specific strategies will need to be place-based.

Foster positive technology and innovation. Both international cooperation and national strategies can foster and spread innovative technologies and policies. The most effective method, as suggested in the report, may involve combining public support for research and development with policies that incentivize the development and diffusion of technology aiding climate action.

PATHWAYS FOR IMPLEMENTATION

A series of enabling conditions are suggested in the report to facilitate implementation of critical mitigation, adaptation, and resilience strategies. These include:

Strong multi-level governance and institutional capacity. Climate adaptation and mitigation strategies must be cross-sectoral, both incremental and transformational, and occur at multiple jurisdictional levels. Government and academic institutions must therefore have the capacity to plan and execute such transformations. A risk lies in adaptation solutions that result in adverse impacts for sustainable development, but participatory governance can reduce these risks of maladaptation.

Transfer and mobilization of finance. Private funds by institutional investors, asset managers, and investment banks directed towards mitigation and adaptation strategies are critical, as are public funds and public policies that lower the risk of these investments for private sector actors.

Public acceptance. Implementing strategies that involve changing human behaviors and lifestyles will require public acceptance. To attain needed long-term behavior change, Indigenous and local knowledge must inform education efforts, information development and exchange, and governance reform.

Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019.

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This report explores scenarios and pathways to addressing the underlying drivers of the deterioration of nature. The report takes into account the anticipated effects of population growth as well as changes in the production and consumption of energy, food, fiber, and water. The report envisions a future in which:

- Nature is conserved, restored, and used sustainably.
- Other societal goals related to food, water, energy, health, and human wellbeing for all are met.
- Other environmental goals, notably climate change mitigation and adaptation, are met.

The report cites the Aichi biodiversity targets, 2030 Agenda for Sustainable Development, the Paris Agreement, and the 2050 Vision for Biodiversity as global goals guiding the report's recommendations.

Agriculture and food systems, as one of the most widespread drivers of land use change, is one of the focus areas of the report. The authors consider feeding humanity and enhancing the conservation and sustainable use of nature to be complementary and closely interdependent goals, that can be achieved through the strategies summarized below.

PROPOSED STRATEGIES

Promote **sustainable agriculture** and **agroecological practices**, such as multifunctional landscape planning and cross-sectoral integrated management that supports the conservation of genetic diversity and agriculture biodiversity. Expand and enhance sustainable intensification in agriculture.

Improve **certification schemes**; **regulate commodity chains** (e.g. through multistakeholder fora and commodity moratorium policies); and engage in more **equitable food value chains**.

Encourage **dietary transitions**, particularly reduced consumption of animal products in developed countries and emerging economies.

Reduce food waste. Solutions differ geographically but include more effective pest control, improved food distribution and storage, consumer education, and less wasteful marketing

practices.

Localize food systems by closing loops between production, consumption, and waste management, integrating agriculture into urban planning, and promoting alternative food distribution options.

Expand **food market transparency** and improve **price stability**, including through public food procurement policies, reducing food taxes and import tariffs, and increasing subsidies and food-based safety nets.

PATHWAYS FOR IMPLEMENTATION

Trajectories of transformation will vary by context, but the report identifies a few broad pathways that apply across sectors and geographies:

- Reform global financial and economic systems to incorporate reduction of inequalities into development pathways, adopt true cost accounting, and reduce overconsumption and waste.
- Recognize the knowledge, innovations, practices, institutions, and values of Indigenous Peoples and local communities and include them in environmental governance, such as through customary management and co-management systems, equitable sharing of benefits, and access and resource rights in national legislation.
- Promote integrative, inclusive, informed, and adaptive governance systems that: address power imbalances in society and decision-making, balance existing and emerging knowledge, involve stakeholders in policy-making, and promote integration across sectors and jurisdictions to overcome segmented decision-making.

The report identifies specific instruments and actions that a diversity of decision-makers can adopt to advance necessary transformations. These key stakeholders are intergovernmental organizations; governments (national, subnational, and local); NGOs; citizens, community groups, and farmers; Indigenous Peoples and local communities; donor agencies, science and educational organizations, and corporate actors.

Unravelling the food-health nexus: Addressing practices, political economy, and power relations to build healthier food systems. IPES-Food. 2017. The Global Alliance for the Future of Food and IPES-Food.

VISIONS FOR GLOBAL FOOD SYSTEMS

We have an urgent mandate to reform our prevailing global model of food and agriculture production, the authors of this report urge. Millions of people across the globe experience severe health impacts from (particularly industrialized) food and agriculture-related causes: employment in hazardous conditions; exposure to contaminants in water, soil, and air; consumption of unsafe or contaminated foods; unhealthy diets; and food and nutrition insecurity. These five health risk factors are compounded by climate change, lack of sanitation, and poverty – factors that themselves worsen from harmful food system practices.

The report notes that each of these risk and compounding factors must be addressed through comprehensive, integrated approaches to achieve:

- A future food system that provides nutritional food to all through environmentally-friendly, safe, and fair production practices.
- Governance of future food systems that systemically acknowledges the linkages between food systems, health, socio-economic development, and environment, and addresses these interconnected issues through multifaceted solutions.

PROPOSED STRATEGIES

Create an integrated science-policy interface. Policy and science are often siloed, and within each field, many solutions and research initiatives are one-dimensional, addressing only one problem or failing to consider the full landscape of interlinked causes and consequences. By bridging these gaps within and between policy and science, the use of evidence can support the development of comprehensive, long-lasting solutions to social-health inequities.

Apply systems thinking in policy. The science-policy interface represents a systems approach in itself, but the report also proposes two other systems approaches:

- A *“food-health-climate nexus”*: An example is the adoption of agroecological production processes to replace current industrial agriculture practices, which are resource-

wasteful, environmentally degrading, and polluting and lead to human health consequences.

- A *“food-health-poverty nexus”*: This strategy acknowledges that health is influenced by many socio-economic determinants, including poverty, that can be perpetuated by the industrial food system model. Ignoring this nexus in food systems reform can deepen inequities – for instance, cheaper food production often implies the exploitation of low-wage labor (a health risk factor due to occupational hazards and a driver of poverty) and results in more processed foods, amplifying problems of malnutrition.

PATHWAYS FOR IMPLEMENTATION

Solutions to develop healthier food systems cannot be achieved without the democratization of food systems and food policy. To reform the current power dynamics currently limiting transformations towards an equitable food-health nexus, the authors advocate for:

Eliminating “blind spots.” Many people most disenfranchised and harmed in global food systems – migrant workers, for example – are not seen or heard in policy debates and are underrepresented in research.

Changing who sets the agenda. A minority of powerful actors largely sets the policy agenda and terms of debate, and may block necessary reforms that are odds with their interests. A similar challenge exists in science: global discourse and access to knowledge is determined by those who finance, guide, and release research and data.

Reconnecting food and agriculture. The growing global culture in which consumers know little about their food’s supply chain is an obstacle to participatory, movement-led food systems reform that protects these key stakeholders’ interests.

The Global Syndemic of obesity, undernutrition, and climate change. The Lancet Global Syndemic Commission.⁴ 2019. *The Lancet*.

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Three pandemics – obesity, undernutrition, and climate change – collectively represent the Global Syndemic. This is the central proposition of this Lancet study, which assesses the drivers in food and agriculture, transportation, urban design, and land use that have contributed to the Global Syndemic, and outlines win-win-win strategies that achieve four primary outcomes:

- Economic prosperity.
- Social equity.
- Human health and wellbeing.
- Ecological health and wellbeing.

Guided by a set of principles, the study's recommendations are systemic in nature; address the underlying causes of the Global Syndemic and associated policy inertia; forge synergies to promote health, environment, and equity; create benefits through double-duty or triple-duty actions; and improve conditions for socially disadvantaged and discriminated populations.

PROPOSED STRATEGIES

Actions that jointly address multiple systems create more fundamental and sustained changes, the report notes; and because people's health-related behaviors are heavily influenced by the environments around them, many recommendations address underlying challenges such as poverty reduction, environmental sustainability, hunger prevention, livable cities, and more.

The report ranked a number of health-related actions (that would address obesity and undernutrition) by their benefits to climate change mitigation and adaptation. Actions that ranked highly (and thus would be considered win-win or win-win-win actions) are:

- Strengthening the integration of nutrition within national policies, programs, and budgets (high mitigation and adaptation potential)
- Increasing official development assistance and averting famines by strengthening local food systems (high mitigation and adaptation potential)
- Improving nutrition literacy and the nutrition workforce capacity (high mitigation potential)
- Investing in systems for knowledge-sharing among stakeholders in the food supply chain (high adaptation

potential)

- Supporting community-influenced public transportation and urban planning policies (high mitigation potential)

The study outlines other “levers” that each addresses an aspect of the Global Syndemic:

- **Strategies to protect the environment:** carbon pricing, pollution regulations, water levies, consumer education, environmental food labelling
- **Strategies to constrain production and marketing of unhealthy foods:** taxation, warning labels, consumer education, social marketing campaigns
- **Strategies to increase the demand for healthy foods:** education, social marketing, government, procurement practices, taxes, subsidies

PATHWAYS FOR IMPLEMENTATION

Many of the report's recommendations are focused on reorienting and refocusing governance systems to tackle the pandemics of obesity, undernutrition, and climate change through an integrated, systems approach:

- **Think in Global Syndemic terms.** Define problems using Global Syndemic terms, define actions that are double- and triple-duty, and make poverty reduction a central goal.
- **Join up silos of thinking and action.** Proactively create platforms for collaborative work on common Syndemic drivers, and link initiatives at global, national, and local levels.
- **Strengthen national and international agency governance levers.** Implement national human rights obligations, accelerate commitments, and create a Framework Convention on Food Systems modeled after the UNFCCC or the WHO Framework Convention on Tobacco Control.
- **Strengthen civil society investments,** including philanthropic investments, to support national policies that address the Global Syndemic and, through capacity and funding, create demand for those policy actions.
- **Reduce the influence of large commercial interests** on public policy development, including by strengthening accountability systems, reducing the influence of corporate lobbying, and address the concentrated power of large food corporations.
- **Focus research** on Global Syndemic determinants and solutions, and learn from Indigenous and traditional people's approaches.

⁴ A full list of members of the Lancet Commission is available at: <https://www.thelancet.com/commissions/global-syndemic>.

An agro-ecological Europe: A desirable, credible option to address food and environmental challenges. Poux, X. and Aubert, P.M. 2018. Institut du Développement Durable et des Relations Internationales (IDDRI).

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Europe will need to feed 530 million people by 2050. In anticipation of this upcoming challenge, Poux and Aubert offer a vision and model for a European food system that:

- Nutritiously and fully feeds the continent's growing population.
- Efficiently manages scarce resources.
- Promotes health, food security, protection of natural resources and biodiversity, and climate mitigation.

The European food system is already widely considered to be productive in terms of volume produced, employment, and trade. It has reduced its greenhouse gas emissions over the past three decades, partially as a result of more concentrated livestock farming and higher nitrogen use efficiency. Yet, as this study points out, this progress has come at high health, financial, and environmental costs: diet-related diseases are on the rise as Europeans eat more unbalanced diets; more chemical inputs are used to achieve high productivity; and biodiversity has steadily decreased. Strategies to transform Europe's food systems will need to address and minimize these issues.

PROPOSED STRATEGIES

Transition to agroecology. The authors' proposed model to meet Europe's food and agriculture challenges is based on agroecology. A combination of low-input agriculture and a high proportion of agroecological infrastructure would restore biodiversity, improve the quality of natural resources, and reduce greenhouse gas emissions. Intermediate actions to transition to an agroecological food system include:

- Optimize use of local resources (for instance, through detailed management of nutrient flows at the territorial level).
- Stop the use of pesticides.
- Dedicate a proportion of cultivated land to agroecological infrastructures, such as hedges, trees, and ponds.

Improve dietary practices. This agroecological model must be accompanied by changes in diets, including reduced

consumption of sugar and meat but increased consumption of fiber and seasonal fruits and vegetables, to meet future demographic pressures without high environmental costs. The authors show that – even with a predicted decline in production volume – their agroecology model can meet future needs while improving health outcomes and respecting cultural preferences.

End plant protein imports. To transition to a truly sustainable European food system, the continent must reduce its reliance on imported food, particularly soy, which maintains demand for products that drive deforestation in other regions worldwide. The proposed scenario eliminates this demand for imports through promoting local supply chains.

PATHWAYS FOR IMPLEMENTATION

The report's primary intent is to prove the technical feasibility of an agroecological European food system and it focuses little on pathways for implementation. It does, however, identify the key public policy areas that would play important roles in building institutional and political support for implementation:

- *Policies on commercialization, trade, and competition.* Europe should not be isolated from the world, but strategies emphasizing competition are not desirable either.
- *Policies on food consumption.* This food systems transformation relies on a reorientation of diets and consumption behavior.
- *Policies on agriculture.* Europe needs to reevaluate allocations of public funds to support this transition.
- *Policies on environment and public health.* Environmental and health issues must be integrated in agriculture policies.

Action should not be limited to these individual sectors; rather, policy-makers should aim to create an environment of coherent, integrated policies that enables large-scale agricultural reform.

Policies that strengthen the nexus between food, health, ecology, livelihoods and identities.

Prato, S., Daño, E., Zundel, T., Li Ching, L., Yoke Ling, C. In *Spotlight on Sustainable Development 2018 | Exploring new policy pathways: How to overcome obstacles and contradictions in the implementation of the 2030 Agenda*. 2018. Civil Society Reflection Group on the 2030 Agenda for Sustainable Development.

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Today's broken food systems are intertwined in a reinforcing cycle of harmful biodiversity, nutrition, health, and livelihood impacts. However, future food systems can drive positive outcomes; the authors envision:

- **Global food systems based on the Peasant Food Web.** The industrialized food system model is gaining strength globally, yet it depletes the most resources and causes the most social, environmental, and public health harm. The Peasant Food Web, in contrast, is one that would produce less waste, increase rural employment, improve food availability and nutritional quality, and decrease greenhouse gas emissions.
- **Food systems transformation that targets multiple goals at multiple scales while mobilizing multiple actors.** This vision aims to address the challenges the authors identify with the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development: although the SDGs encourage cross-sectoral collaboration, their design and implementation still rely on delineated institutions and siloed solutions and thus cannot effectively tackle the interlinked impacts of food systems.

PROPOSED STRATEGIES

Transition to agroecology. The authors propose agroecology as a practical systems-thinking, holistic, positive alternative to harmful food systems practices. It diversifies farms and farming landscapes while promoting soil health and nurturing relationships between species, and achieves high yields without the need for chemical inputs. It promotes better nutrition and food security, builds the environmental and climate resilience of a landscape, and is localized, which means farmers can adapt the system to their needs and receive its benefits – turning agroecology into a mechanism for poverty-reduction.

Empower peasants. Food systems policies and research should promote the rights, economic livelihoods, and political enfranchisement of smallholder farmers. Some of the actions recommended in the report include to support interdisciplinary

research that responds to the priorities of peasants and includes them as co-creators of knowledge; strengthen the role of farmer organizations in policy design and implementation; establish fair wages and working conditions for food and agricultural workers; and reform agrarian policies to recognize the rights of peasants, fisherfolk, pastoralists, and Indigenous Peoples to land and other resources.

PATHWAYS FOR IMPLEMENTATION

Strengthening a “food democracy” will be critical to achieving the report's visions. This means diminishing corporate influence in policy-making and increasing government leadership in food systems transformation. It also describes greater public participation and influence in food systems transformation. A few obstacles stand in the way of this system change:

- **Dematerialization:** The cost of food to consumers is becoming less related to food's physical characteristics and more to its “immaterial dimensions,” such as advertising or investor profit. The desirability and value of food, similarly, has less to do with the physical quality of the food and its production and more with how food is marketed.
- **Digitalization:** As a result of the digitalization of food production and commercialization, consumers (and even producers) are becoming delocalized from their food systems. This digitalization decreases the public's personal investment in food systems and renders it challenging for smallholder farmers to keep up with emerging technologies and to enter new markets.
- **Financialization:** Financial actors, corporations, and technology agents increasingly control everything from agricultural activities to upstream operations to consumer food choices. Agricultural resources, including land and infrastructure or genetic resource patents, are turned into financial assets unlinked to their physical locations or actual use.

Contribution of the land sector to a 1.5°C world. Roe, S., Streck, C., Obersteiner, M., Frank, S., Grsicom, B., Drouet, L., Fricko, O., Gusti, M., Harris, N., Hasegawa, T., Hausfather, Z., Havilk, P., House, J., Nabuurs, G.J., Popp, A., Sanz Sanchez, M.J., Sanderman, J., Smith, P., Stehfest, E., Lawrence, D. 2019. *Nature Climate Change*.

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According to modeling conducted and compiled by authors, transforming the land sector by deploying strategies in agriculture, forestry, wetlands, and bioenergy could feasibly and sustainably contribute 30% of global mitigation needed to deliver on the 1.5°C target of the Paris Agreement. The roadmap for land sector reform the study outlines is intended to:

- Achieve the 1.5°C target of the Paris Agreement.
- Enhance co-benefits across biodiversity, water, air, soil, resilience, food security, and livelihoods.
- Deliver on other international commitments and policies such as the Sustainable Development Goals (SDGs).

The report notes that the difference between a roadmap to achieve a 1.5°C target and a 2°C target is significant. In particular, the latter would require earlier and deeper reductions in agricultural and demand-side emissions, as well as enhanced carbon removals across the land sector.

PROPOSED STRATEGIES

In reviewing model assessments of greenhouse gas emission trajectories in the agriculture sector, the authors found the largest reductions would result from intensification of the livestock sector to reduce enteric fermentation; changing irrigation and fertilization practices in rice cultivation; and reducing cropland soils and pastures. Other strategies include:

Carbon dioxide removal. Strategies for carbon dioxide removal relevant to the agriculture sector include agroforestry and soil carbon sequestration in croplands, including through erosion control, use of larger root plants, reduced tillage, cover cropping, and restoration of degraded soils.

Changes in agricultural practices. These reforms include improving productivity and reducing resource use in the livestock sector; reducing production and use of synthetic fertilizers; improving manure management; reducing and intensifying cropland and pastures; and improving water and fertilization management in rice cultivation.

Reforms in consumer behavior and other demand-side strategies.

Shifting diets towards plant-based diets for half of the global population is a key recommendation in the report. Public health policies, consumer campaigns, and development of new foods can support this transition. The report also calls for reducing food waste through consumer campaigns, private sector policies, supply chain technologies, improved food labelling, and conversion of waste to biogas. Food loss can be reduced through improved handling and storage practices, training, and new technologies.

The authors note that decreasing meat consumption and reducing food waste will reduce land used for feed and water use and decrease soil degradation, thus improving resources key to improving food security.

PATHWAYS FOR IMPLEMENTATION

The report identifies three primary barriers to achieving a 1.5°C target: political inertia, weak governance, and lack of finance. In particular, as these barriers apply to agriculture and food systems transformation,

- Farmers are reticent to change their practices due to lack of finance, high transition costs, and low expected returns from changed practices.
- Demand side measures have proceeded slowly due to limited awareness and political support, and challenges eliciting and maintaining behavioral change.
- Reductions in agricultural emissions have been limited by concerns about negative tradeoffs, such as food security, economic returns, and adverse impacts on smallholders.

To overcome these barriers, the report emphasizes the importance of **increased dialogue between scientists and policy-makers** to bridge the knowledge gap around “no regret” options for mitigation, and to mobilize political action. The report also recommends **supporting research** on breakthrough technologies and approaches in behavioral science, meat substitutes, livestock production systems (including new feeds), improved fertilizers, and seed varieties.

The African Dialogue on the World in 2050: How can agriculture contribute to meeting the SDGs? Report on a multi-actor dialogue for The World in 2050 (TWI2050). Sustainable Development Goals Center for Africa and SwedBio/Stockholm Resilience Centre at Stockholm University. 2017.

VISIONS FOR GLOBAL FOOD SYSTEMS

As participants reiterated throughout this African Dialogue on the World in 2050, agriculture has long underpinned culture and livelihoods across the African continent. Food systems transformation consequently emerged from the discussion as a key lever to improve social, economic, and environmental resilience across the continent over the next three decades.

Participants outlined a vision of Africa in 2050 in which:

- Food systems practices are grounded in local values and knowledge, and food systems policies respect and protect local cultural values of food and agriculture.
- Agriculture drives socio-economic development. Rural and agricultural livelihoods are attractive, slowing rural out-migration, and women and youth participation in agribusiness increases.
- Land planning and agricultural practices protect agro-biodiversity and support ecosystem services.
- Increased agricultural diversification and productivity eradicates hunger and improves nutrition.

PROPOSED STRATEGIES

Achieve gender equity. The agriculture sector – as well as the national economy – will be more prosperous and foster greater shared wealth if the gender gap is eliminated in social and legal rights, political participation, and ownership of land and other assets.

Attract youth. Young people are exiting the agriculture sector to migrate to cities, calling into question its capacity in the long-term to meet the increasing demand for food in Africa. Incentives and policies should seek to retain youth in agribusiness, which will require eliminating the association between farming and poverty.

Develop and share knowledge. Research and knowledge exchange was identified as an important strategy for food systems transformation throughout the dialogue. Research is needed that:

- Balances the new frontiers of technology, science, and

- innovation with traditional, Indigenous, local knowledge.
- Is place-based, taking into account the historical, social, and political contexts of the continent, specific countries, and individual communities.
- Is led by African researchers, and promotes African perspectives.
- Supports smallholder farmers, including through agricultural extension services.

Promote ecologically-friendly agricultural practices and policies.

These include comprehensive land planning; agri-policies that compensate farmers for ecosystem services; policies that support seed and livestock diversification to replace monocropping and organic farming methods.

Invest in smallholder agriculture. Smallholder farmers have been left out of public investments in agriculture, which has largely focused on commercial farming that respects neither local culture nor environmental health.

Localize food systems wealth. Due to the growth of export-oriented, commercial agriculture, there remains little continental control of circulation of money and trade. That value should be concentrated along local and regional supply chains.

PATHWAYS FOR IMPLEMENTATION

Participants in the dialogue expressed frustration with visions of “progress” in Africa that exclude the agriculture sector and particularly overlook smallholder farmers. Implementing the recommended strategies will require overcoming these historical, cultural, and governance barriers to change.

Stronger governance of the agricultural sector will also be needed: poor land tenure systems currently do not offer security to farmers, agricultural policies are not adequately implemented and enforced, and smallholder agriculture is frequently disregarded in national strategy. The development of agri-policies addressing these limitations should rely upon the active participation of local communities and will require strong and accountable institutions.

Future of food: A lighthouse for future living, today. World Business Council for Sustainable Development (WBCSD). 2018.

VISIONS FOR GLOBAL FOOD SYSTEMS

Proposals to achieve sustainable lifestyles often emphasize the need to reduce material consumption, which is an unattractive option for businesses, consumers, and policy makers. This report aims to prove that a sustainable lifestyle can actually be better for these groups than an unsustainable one, and business interests do not need to be at odds with that transition.

The WBCSD's "lighthouse" – or vision – for a future of food is one that:

- Respects values of environmental sustainability, including by reducing waste.
- Acknowledges consumers' desires and changing market trends and provides healthy, affordable, safe food.
- Connects people, nature, and food and celebrates food.
- Is transparent, cruelty-free, and adheres to human rights standards.

PROPOSED STRATEGIES

The report intends to guide businesses to develop sustainable solutions that are beneficial both to them and to consumers, and the strategies are oriented towards actions businesses can take.

Change growing practices. The report notes that demand for food is increasing with the growing purchasing power of an expanding global middle class. This trend intersects with growing scarcity of land and water resources. Proposed strategies to transform growing practices to meet these macro trends are vertical farming, conservation agriculture, and urban farming.

Change production, packaging, and distribution practices. People's relationships with food are increasingly unhealthy, as represented by the quantity of waste produced and diet-related diseases. Consumers are also becoming more aware of their food systems, demanding healthier and more sustainable food. Businesses can respond through innovations in smart packaging, alternative proteins, and waste reduction

technologies, for example.

Enhance consumers' experience of food. The consumers of the future – and increasingly of the present – pay more attention to food, which is increasingly becoming a focal point of their identities and lifestyles. Businesses should offer greater transparency and information for consumers, and develop technologies to personalize consumers' experiences of shopping for and preparing food.

PATHWAYS FOR IMPLEMENTATION

These strategies primarily rely on companies to reform their practices across the food system and on the public to adopt more sustainable behaviors. As companies improve their own practices, they also play the role of convincing consumers that healthier, more environmentally-friendly food systems – and diets – is the best option. Because public acceptability is a key pathway for implementation of the report's vision, the authors emphasize that food systems transformation should be guided by the needs and desires of consumers and value them as active participants in the transformation. The report acknowledges that consumers' preferences may not always align with the envisioned outcomes, but does not discuss how to reconcile this possible divergence.

Not all action items proposed in the report – such as eliminating human rights abuses in food systems – rely on consumer behavior change; they demand significant investment and reform on the part of companies, which can be motivated through "enabling" factors such as policies and incentives (both financial and non-financial).

Shaping the future of global food systems: A scenarios analysis. World Economic Forum's System Initiative on Shaping the Future of Food Security and Agriculture; Deloitte Consulting LLP. 2017.

VISIONS FOR GLOBAL FOOD SYSTEMS

This report presents four scenarios for future food systems that arise from two “critical uncertainties” and their related implications for health and environment. The first “critical uncertainty” is demand for agricultural commodities: will demand be more resource-intensive or resource-efficient? Secondly, will markets be highly connected or unconnected? Market connectivity is defined as the degree of trade openness, trust in and resilience of commodity markets, and inclusivity of technological innovations.

The scenarios also account for “predictable forces of change” over the next few decades. The most significant of these are demographic changes (urbanization and population growth) and climate change. These critical uncertainties and predictable forces of change affect which of the report’s four scenarios for future food systems is most likely to materialize:

- Survival of the richest (low connectivity, resource-intensive consumption)
- Unchecked consumption (high connectivity, resource-intensive consumption)
- Open-source sustainability (high connectivity, resource-efficient consumption)
- Local is the new global (low connectivity, resource-efficient consumption)

Each of these scenarios achieves the report’s core values of food systems inclusivity, efficiency, sustainability, and health to a different degree (some barely at all). In the “best case scenario” (high connectivity and resource-efficient consumption), food systems are still vulnerable to weather, economic and political shocks, and inequality, but:

- Companies and farmers benefit from increased productivity and have access to more information.
- Global markets are open and stable.
- Sufficient nutritious and diverse food sources are available.
- Policies support sustainable choices and healthy diets.

PROPOSED STRATEGIES

Support open and responsible markets. Should food systems lean towards globalization or localization? The report cautions against protectionist trade policies and fragmented markets,

but also notes that today’s global industrialized model of food production hurts human and planetary health and exacerbates inequality. The report suggests that global trade and cooperation, alongside safeguards and provisions for responsible practices, may be one of the most effective strategies to tackle food systems challenges and related drivers of change, such as climate change.

Encourage healthy and resource-efficient consumption.

Consumer behavior has the power to transform global health and sustainability. Consumers should be incentivized, enabled, and encouraged to eat more resource-efficient, healthy diets. Importantly, however, a healthy and nutritious diet does not always equate to one that is more resource-efficient. This dichotomy must be bridged to mitigate any negative consequences of food systems transformation.

Efficiently manage resources. The need to carefully manage and utilize natural resources is reiterated throughout the report. It suggests strategies to increase yields and food systems efficiency, but does caution against potential unintended consequences of this approach: for instance, in one scenario, the outcome of domestic resource protection is aggressive use of foreign resources.

PATHWAYS FOR IMPLEMENTATION

Through business. As drivers of innovation in society, the private sector should take leadership in driving progress in food systems reform. Businesses can and should leverage technology and other innovations to address health, nutrition, and sustainability challenges, as well as reform their own operations to be more resource-efficient. Because achieving the report’s vision partially relies on stable and healthy market forces, businesses also have responsibility for contributing to greater resiliency in global markets (e.g., through increased transparency and risk-management policies).

Through government. The report calls for governments to pass “smart policies” through a “whole of government” approach: by collaborating across traditional policy arenas. Specific examples proposed include integrating nutrition into education systems, leading social marketing campaigns to change consumer behavior and promote health outcomes, or subsidizing highly nutritious crops.

Transformations to achieve the Sustainable Development Goals. The World in 2050 Initiative - International Institute for Applied Systems Analysis (IIASA). 2018.

VISIONS FOR GLOBAL FOOD SYSTEMS

This report's vision for the world in 2050 is grounded in sustainable development: a joint social and environmental challenge to build a world that meets human needs within planetary boundaries. The Sustainable Development Goals (SDGs) are an important component of that future, but will require multidimensional and integrated transformations. The report identified six such crucial pathways for transformation: human capacity and demography; decarbonization and energy; smart cities; digital revolution; responsible consumption and production; and food, biosphere, and water. Although these categories are highly interrelated and must be in order to accomplish multiple goals, the latter two are most central to food systems issues.

The authors present a vision for the world in 2050 in which:

- Food systems are based on a circular economy: consumption and production practices limit natural resource use, pollution, and waste.
- Food systems cause minimal environmental degradation and are resilient to environmental changes, included those caused by climate change.
- Food systems provide healthy and affordable food for all, eradicating global hunger.
- Food systems create wealth while ensuring no one is left behind.

PROPOSED STRATEGIES

Reform consumption practices. Healthier, more sustainable diets (which will require a reduction in meat consumption) should be encouraged. Consumers should also limit food waste.

Reform production practices. This includes eliminating subsidies for harmful production methods, minimizing fertilizer and water use, and adopting agroecological methods. Reform will also require more effective regulation of land use, including to limit future agricultural production to land currently used for agriculture and protecting all other lands for ecological purposes.

Improve governance and public services. Strong institutions should enable and improve human capacities and capabilities

through healthcare, education, and fair labor markets. Governments should develop and maintain essential, strategic infrastructure in energy, food production, mobility systems, and more. And finally, governance systems should create an enabling environment – as well as checks and balances – for science, technology, and innovation that contribute to future progress towards SDGs.

PATHWAYS FOR IMPLEMENTATION

Many of today's sustainable development strategies are one-dimensional and insufficiently bold; "Sustainable development is not a self-organizing property of market-based economic systems," the authors denounce. To achieve the intended outcomes, proposed transformations must be scaled up and catalyze multiple actors and mechanisms:

- Key drivers of sustainability transformations: political institutions (to provide public goods and services); social institutions (to propagate social norms and cultural values); and knowledge organizations (to incubate creativity and innovation).
- Key instruments: economic (e.g., fiscal frameworks, regulations and mandates); political (e.g., government-led integrated planning, public-private partnerships, international cooperation); and social (media, changing norms and culture, greater social equality).

A range of obstacles currently limits the capacity of these institutions and tools to embark upon transformational change. The **divergent interests of diverse actors** are one challenge: for instance, companies that benefit from unsustainable practices in the short-term control significant financial and political capital, holding sway over opportunities for major reform. Another challenge is the current **limited capacity of governments** to design and implement policies that look decades ahead, balance multiple stakeholders, and are cross-sectoral. Finally, the report identifies the public **resistance to change**. These sustainability transformations will likely disrupt the status quo. Indeed, they fundamentally must be disruptive if they are to bridge the growing gap between our current unsustainable practices and a healthy, ecological future that can sustain a growing global population. Such disruption may not be politically popular, especially if it demands individual behavior change.

Creating a sustainable food future: A menu of solutions to feed nearly 10 billion people by 2050. World Resources Institute. 2019.

VISIONS FOR GLOBAL FOOD SYSTEMS

Population growth and income growth will drive a major increase in demand for food – particularly animal-based food – over the next thirty years, this report predicts. To tackle this growing crisis, the report presents 22 broad strategies to achieve global food systems by 2050 that:

- Meet growing demands for food.
- Reduce and avoid deforestation.
- Reforest or restore abandoned and unproductive land.
- Achieve the three goals above in ways that protect the climate, promote economic development, and reduce poverty.

To realize this vision, food systems will also need to achieve three overarching objectives: 1) Close the **food gap**, or the difference between the quantity of food produced today and the quantity that will be required to meet demand in 2050; 2) Close the **land gap**, or the difference between the land area dedicated to agriculture globally today and the area that will be required in 2050; and 3) Close the **greenhouse gas mitigation gap**, or the difference between anticipated GHG emissions from agriculture in 2050 and the maximum level of emissions allotted to agriculture to maintain global warming below 2°C.

PROPOSED STRATEGIES

Protect and restore natural ecosystems. Avoiding agricultural expansion is a key priority of the report. The authors recommend boosting productivity and linking governance to productivity gains and avoided agricultural expansion; conserving and restoring peatlands, and reforesting abandoned, unproductive, and liberated agricultural lands.

Improve natural resource use efficiency. This is identified as the single most important step for meeting both food production and environmental goals. Efforts to increase agricultural yields must be linked with legal land protections to prevent land conversion and agricultural expansion. Improved water management will also be essential.

Slow growth in demand for food and other agricultural products. This will require reducing food loss and waste; shifting diets away from meat towards plant-based foods; avoiding the diversion of edible crops and agricultural land into bioenergy production; and accelerating voluntary reductions in fertility levels by improving women's access to education and healthcare in the Global South.

Increase food supply (without expanding agricultural land). This should include increasing livestock and pasture productivity through improved breeding, soil and water management, feed quality, grazing management, and other practices. Existing cropland should be maximized.

Increase fish supply. This includes expanding and improving aquaculture and wild fisheries management.

Reduce climate impact of agricultural production. The authors recommend protecting and restoring forests, savannas, and peatlands as a key climate mitigation strategy. Agricultural practices and new technologies to reduce GHG emissions and improve agricultural energy efficiency will also be necessary to limit the negative climate impact of food systems.

PATHWAYS FOR IMPLEMENTATION

The authors identify government policy and technological innovation as two of the most essential pathways and tools to implement the proposed strategies. Governments play key roles to:

- Shape culture and the consumption environment through public policy.
- Protect the environment by managing natural resource use and regulating manufacturers and industrial producers.
- Provide social services (particularly education and reproductive health).
- Provide technical and financial assistance to farmers to support their transition to more sustainable practices.
- Pass regulations that spur innovation in the private sector.

The authors note that this last role is particularly important: cost-effective technological innovations could transform the world's food systems at all scales and stages. The report particularly identifies promising opportunities in:

- Product innovation (e.g., plant-based meat substitutes, safer fertilizers and organic sprays)
- Farming technologies (e.g., crop breeding methods, additives that lower methane emissions from livestock)
- Processing and handling technologies to reduce waste (e.g., methods to prevent decomposition without refrigeration)

